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Article

Effect of Astragalus polysaccharide supplementation on growth performance and plasma parameters of weaned piglets under commercial condition

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Abstract

The aim of this study was to evaluate the effect of Astragalus polysaccharide (APS) supplementation on the growth performance, plasma biochemical parameters, and plasma immune and antioxidant indexes of weaned piglets in a commercial swine farm. A total of 120 piglets weaned at 22 days and allocated to 2 groups, and fed a basal diet either without (CTR) or with 200 mg/kg of APS in a local commercial farm for a 42-d experiment. At end of the trial, one piglet from each pen was selected for blood sampling. The results showed that dietary APS decreased the feed conversion ratio (FCR) compared to the CTR group from day 14 to day 28 and day 0 to day 42 (P = 0.08 and 0.02, respectively). In addition, supplementation of APS had the tendency to increase the plasma superoxide dismutase activity and IgG content of piglets compared to the CTR group on day 42 (P = 0.06 and 0.09, respectively). Results in this study suggested that dietary APS might have a beneficial effect on growth performance and health status of weaned piglets under the commercial condition.

1 Introduction

There are significant changes in the histology and biochemistry of the gastrointestinal tract during the weaning phase that decrease digestive and absorptive capacity and contribute to post-weaning diarrhea (Pluske et al. 1997). It is noteworthy that polysaccharide fractions of Astragalus mongholicus and Astragalus polysaccharide (APS) have been reported to reduce the incidence of diarrhea in animals (Shao et al. 2004) and use as an immunomodulator (Mao et al. 2005; Zhuge et al. 2012). Additionally, there is evidence that dietary supplementation with APS can improve growth performance (Yuan et al. 2006; Kang et al. 2010) and regulate the digestive and absorptive function of weaned pigs (Yin et al. 2009).

The antimicrobials usage as growth promoters or to prevent diseases provides great benefits for the growth and health of piglets, while it would also provides potential risks for human health through the transfer of resistant bacteria and associated genes via the food chain, direct contact or the environment (Aarestrup et al. 2008). China has been limiting the usage of antibiotics for growth promoters in animal feed since that was banned by the European Commission in 2006, while the productive performance in Chinese commercial swine farms is still low. It has been reported that on average, Chinese swine farms wean 22 piglets per sow per year (van Dooren, 2018), which may be due to many issues such as equipment, management and feed quality. Thus, the effective strategies aiming to improve health status of piglets and limit antibiotic use during the post-weaning period in swine production particular in the commercial swine farms are needed (Stanton 2013).

Although APS has gained interests in medicine and health-related research in last decades, the information on efficacy of APS on growth performance and health status of weaned piglets in a Chinese commercial swine farm is scarce. Therefore, the objective of this study was to evaluate the efficacy of dietary APS supplementation on growth performance, plasma biochemical parameters, immune and antioxidant indexes of weaned piglets under the commercial condition.

2 Material and method

The animal protocol for this research was approved by Animal Care and Use Committee of the Feed Research Institute of the Chinese Academy of Agricultural Sciences.

2.1 Animals and treatments

The study was conducted in a local commercial swine farm, Langfang, Heibei, China. A total of 120 crossed piglets (Duroc × (Landrace × Yorkshire)) with an initial body weight of 7.38 ± 1.16 kg were used in a 42-day study. The pigs were weaned at 22 ± 2 days of age and allocated randomly on the basis of body weight to 2 treatments in a randomized complete block design. The dietary treatments were: the CTR group (basal diet) and the APS group (basal diet + 200 mg/kg APS). There were 60 piglets in each treatment, with 10 piglets per pen. The APS product was provided by Beijing Centre Biology Co., Ltd. (Beijing, China). Each 2.00 × 2.00 m pen was equipped with a feeder and a water nipple to allow *ad libitum* consumption of feed and water. The temperature was kept at 28 ± 2°C, and relative humidity was maintained at 65-75%. Feed intake was determined biweekly. Piglets were weighed 1 h prior to feeding in the morning at the beginning of the experiment (day 0), day 14, 28 and the end of the experiment (day 42). The basal diet was formulated and manufactured before starting the trial, without the inclusion of any antibiotic growth promoters or antibiotic growth promoter alternatives. Ingredients and chemical contents of the basal diets are summarized in Table 1. All diets were formulated according to National Research Council (2012) recommended requirements of nutrients by swine.

2.2 Experimental observations and measurements

The body weight and feed intake were recorded at days 14, 28 and 42 for each replicate to determine the average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR). On day 42, one piglet from each pen, close to the pen average weight, was selected to collect blood from jugular vein. Blood samples were collected into heparinized test tubes to analyze the plasma biochemical parameters, antioxidant and immune status differences among dietary treatment, and were immediately centrifuged at 3000 × g for 10 min at 4°C to separate plasma. Then the samples were stored at -20°C until analysis.

The glutathione peroxidase (GSH-Px) activity, total superoxide dismutase (T-SOD) activity, and malondialdehyde (MDA) content in plasma were analyzed using commercially available kits (Nanjing Jiancheng Bioengineering Institute, Nanjing, Jiangsu, China), and all the parameters were evaluated according to the manufacturer’s instructions. The contents of blood urea nitrogen (BUN), total protein (TP) and glucose (GLU) in plasma were determined by an automatic biochemistry analyzer (Zhuoyue-310, Shanghai Kehua Bio-Engineering Co., Ltd., Shanghai, China) in accordance with each kits (Shanghai Kehua Bio-Engineering Co., Ltd., China). Quantification of immunoglobulin G

(IgG) levels in plasma samples were assayed in duplicate using commercial porcine ELISA kits according to the protocols provided by the manufacturer (Nanjing Jiancheng Bioengineering Institute, Nanjing, China

Table 1. Ingredient and chemical composition (g/kg) of the diets (as fed basis)

Item	Prestarter (day 0 to 14)	Starter (day 14 to 42)
Ingredients		
Corn	563.1	617.5
Soybean meal	337.6	282.2
Corn protein powder (50% CP)	40.0	40.0
Vegetable oil	17.3	23.1
Dicalcium phosphate	19.0	13.9
Limestone ($CaCO_3$)	13.6	14.3
Salt	3	3
DL-Methionine	1.6	0.9
L-Lysine HCl	1.4	1.7
Vitamin and mineral premix1	2.4	2.4
Choline chloride (50%)	1	1
Nutrient composition2		
ME, MJ/kg	12.13	12.55
Crude protein	210 (209)	190 (187)
Calcium	10	9
Available phosphorus	4.8	3.8
Lysine	11	10
Methionine	5	4
Methionine + cysteine	8.2	7.2

1 Premix supplied per kg of diet: retinyl acetate, 3.75 mg; cholecalciferol, 0.0625 mg; α-tocopherol acetate, 18.75 mg; menadione, 2.65 mg; thiamine, 2 mg; riboflavin, 6 mg; cobalamin, 0.025 mg; biotin, 0.0325 mg; folic acid, 1.25 mg; calcium pantothenate, 12 mg; niacin, 50 mg; manganese ($MnSO_4 \cdot H_2O$), 100 mg; copper ($CuSO_4 \cdot 5H_2O$), 8 mg; Zinc (ZnO), 75 mg; iron ($FeSO_4 \cdot 7H_2O$), 80 mg; selenium (Na_2SeO_3), 0.15 mg; iodine (iodised NaCl), 0.35 mg.

2 The nutrient levels listed in parentheses are determined values, others are calculated ones

2.3 Statistical analysis

All experimental data were analyzed by general linear model (GLM) of SPSS 24.0 (SPSS Inc., Chicago, IL). The model included the treatment effect (2 groups), and the pen represented the experimental unit for growth performance, while individual piglet was used as experimental unit for plasma parameters. Treatment effects were considered significant at $P \leq 0.05$, whereas a trend for a treatment effect was noted for $P \leq 0.10$.

3 Results and discussion

The effect of dietary APS supplementation on growth performance of weaned piglets is shown in Table 2. During the whole period of the trial, dietary APS decreased the feed conversion ratio (FCR) compared to the CTR group (P = 0.02). In addition, APS supplementation tended to reduce the FCR compared to the CTR group from day 14 to 28 (P = 0.08). In consistent with the observations in our study, previous studies indicated that supplementation of APS to the diet for weanling pigs enhanced feed efficiency (Yuan et al. 2006; Yin et al. 2009; Kang et al. 2010). However, no difference in average daily gain (ADG) between the CTR and APS groups was observed in all the periods of the trial (P > 0.05), which may be due to the filed condition and feeding phase. In our study, the improvement in ADG by dietary APS was gradually enhanced with age of the piglets, while the ADG of piglets in both groups was similar during the first 2 weeks post weaning. Kang et al. (2010) added APS to the diet at a dose of 500 ppm of feed but failed to improve the growth performance of weaned piglets from day 0 to 14. Yin et al. (2009) also observed that piglets fed with 1000 ppm APS did not increase ADG during first 2 weeks post weaning. Therefore, dietary APS might improve the growth of piglets not in the beginning period post weaning but in the late nursery phase.

The effect of APS supplementation on the plasma biochemical parameters, antioxidant activities and IgG content on 42 days of the trial are presented in Table 3. Results showed that supplementation of APS had the tendency to increase the plasma IgG content compared to the CTR group (P = 0.09). Yuan et al. (2006) suggested that dietary APS could be used as a potential immuno-modulating agent by affecting cellular immunity to improve growth and immune function of weaned pigs. Adding APS diet tended to increase plasma T-SOD activity (P = 0.06), and showed lower mean values in the contents of plasma MDA (3.68 nmol/mL) though in this case differences compared with the CTR group (4.62 nmol/mL) were not significant (P = 0.21). Zhao & Shen (2005) suggested that the accumulation of ROS might induce numerous disorders and cause a variety of impairments to tissues. Similar with the observations in our study, Zhong et al. (2012) reported that dietary APS exhibited antioxidant effects in newly weaned lambs by increasing T-SOD activities in blood, and Jia et al. (2012) concluded that APS could be used as a hepatoprotective and antioxidant agent in fish. In our study, we observed the decreased mean value in the content of BUN of piglets fed the APS-containing diets compared to the CTR group (1.77 mmol/mL vs. 2.64 nmol/mL, P = 0.12), which in turn might have prevented or reduced the extent of the immune system activation in the group, thus allowing for a more efficient utilization of dietary protein and amino acid (AA) for growth or body protein deposition. Yin et al. (2009) reported that APS might ameliorate the digestive and absorptive function and regulate AA metabolism to beneficially increase the entry of dietary AA into the systemic circulation.

Table 2. Effect of APS supplementation on growth performance of weaned piglets1

	CTR	APS	s.e.m.	P-value
Day 0 to 14				
Day 0 BW, kg	7.38	7.39	0.48	1.00
ADG, g/d	132	133	13	0.96
ADFI, g/d	242	232	16	0.64
FCR	1.895	1.771	0.097	0.40
Day 14 to 28				
ADG, g/d	275	292	21	0.58
ADFI, g/d	481	474	29	0.87
FCR	1.758	1.638	0.042	0.08
Day 28 to 42				
ADG, g/d	444	470	27	0.52
ADFI, g/d	722	712	45	0.88
FCR	1.641	1.511	0.058	0.18
Day 0 to 42				
ADG, g/d	283	298	15	0.52
ADFI, g/d	482	473	26	0.81
FCR	1.705	1.584	0.031	0.02

CTR = basal diet without additive; APS = Astragalus polysaccharide; BW = body weight; ADG average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio.

[1] n = 6 replicates/treatment

Table 3. Effect of APS supplementation on the plasma biochemical parameters, IgG content and antioxidant activities of weaned piglets[1]

	CTR	APS	s.e.m.	P-value
BUN, mmol/L	2.64	1.77	0.36	0.12
TP, g/L	0.81	0.83	0.04	0.69
Glucose, mmol/L	5.20	5.22	0.40	0.98
GSH-Px, nmol/mL	596	677	70	0.45
MDA, nmol/mL	4.62	3.68	0.49	0.21
T-SOD, U/mL	62.48	73.01	3.34	0.06
IgG, mg/mL	6.01	7.53	0.56	0.09

CTR = basal diet without additive; APS = Astragalus polysaccharide; BUN = Blood urea nitrogen; TP = total protein; GSH-Px = glutathione peroxidase; MDA = malondialdehyde; T-SOD = total superoxide dismutase; IgG = Immunoglobulin G.

[1] n = 6 replicates/treatment.

1 Conclusions

In conclusion, the supplementation of APS in weaned piglets' diet has the potential to increase the growth performance of weaned piglets in the commercial swine farm but probably in the late nursery phase, and dietary APS may improve the plasma immune and antioxidant status of weaned piglets under the commercial condition. More studies on APS application may benefit the swine industry.

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